(12) UK Patent Application (19) GB (11) 2 113 847 A

(21) Application No 8235124
(22) Date of filing 9 Dec 1982
(30) Priority data
(31) 56/204299
(32) 17 Dec 1981
(33) Japan (JP)
(43) Application published 10 Aug 1983
(51) INT CL[3] A61B 5/02
(52) Domestic classification G1N 19B2P 19D10 19X7 30P1 30P2 ENH
(56) Documents cited
GBA 2022839
GBA 2016152
GB 1579690
GB 1550089
(58) Field of search G1N

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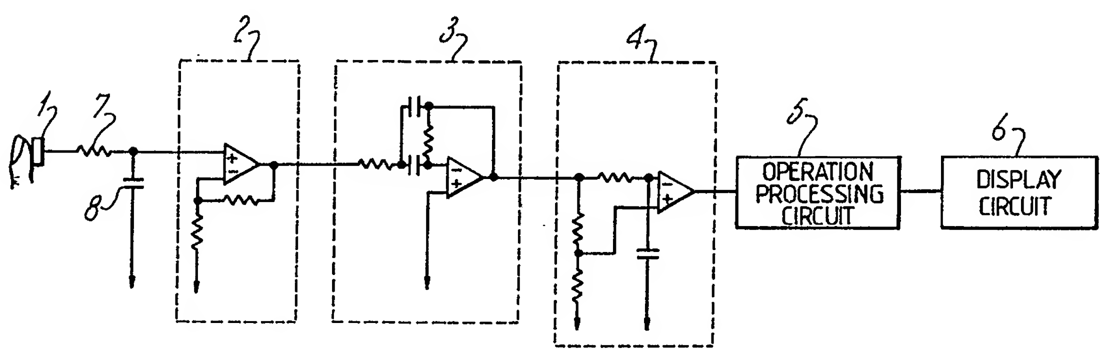
(54) A heart-beat rate indicator

(57) A heart-beat rate indicator comprises a detection electrode (1) receiving an electrocardiac potential signal, circuitry (2, 3, 4, 5) receiving the electrocardiac potential signal and determining therefrom a heart-beat rate, and a low-pass filter (7, 8) connected between the detection electrode and the circuitry to attenuate signals in the megahertz band and pass the electrocardiac potential signals substantially without attenutation, thus protecting the heart-beat rate indicator from the application of electrostatic charge. Circuits 2, 3 and 4 comprise a conventional amplifier, band pass filter and comparator, respectively.

Fig.4.



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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Fig.1.

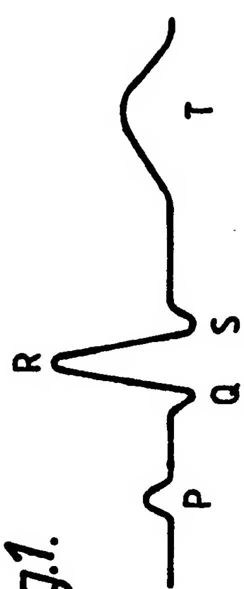

P
Q
R
S
T

Fig.2.

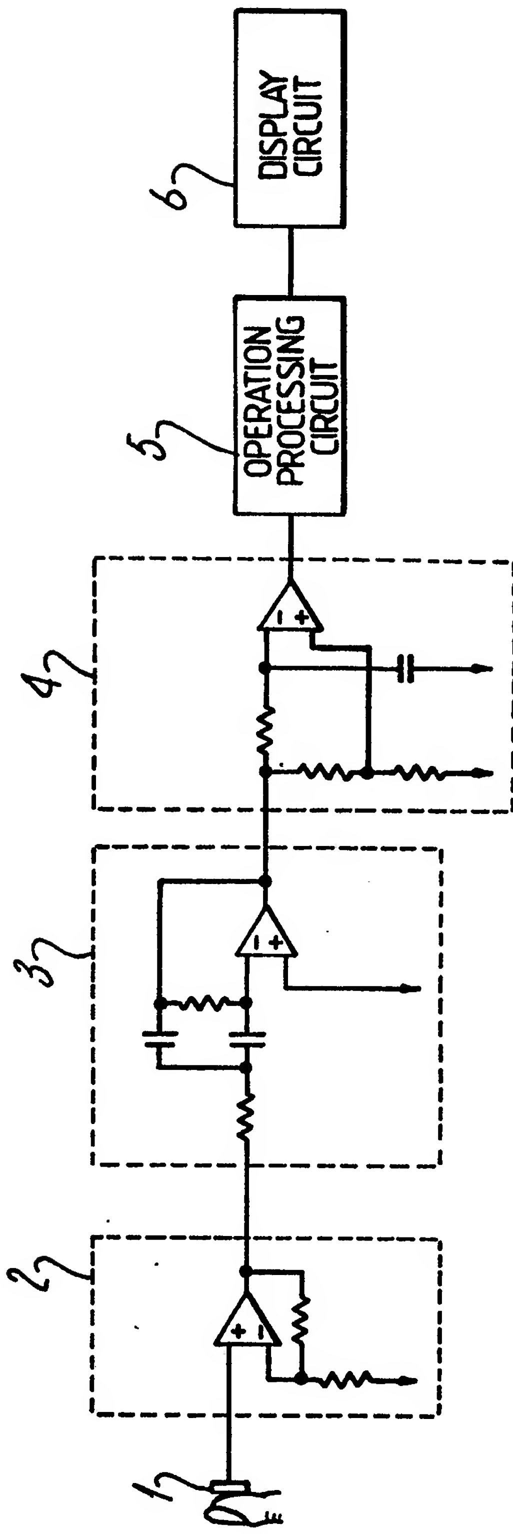

1
2
3
4
5
OPERATION PROCESSING CIRCUIT
6
DISPLAY CIRCUIT

Fig.3.

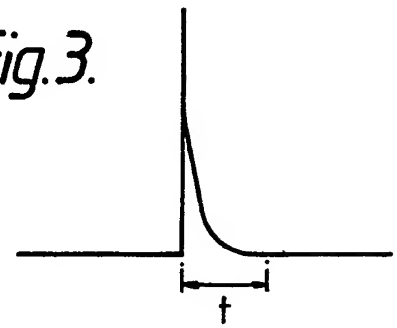
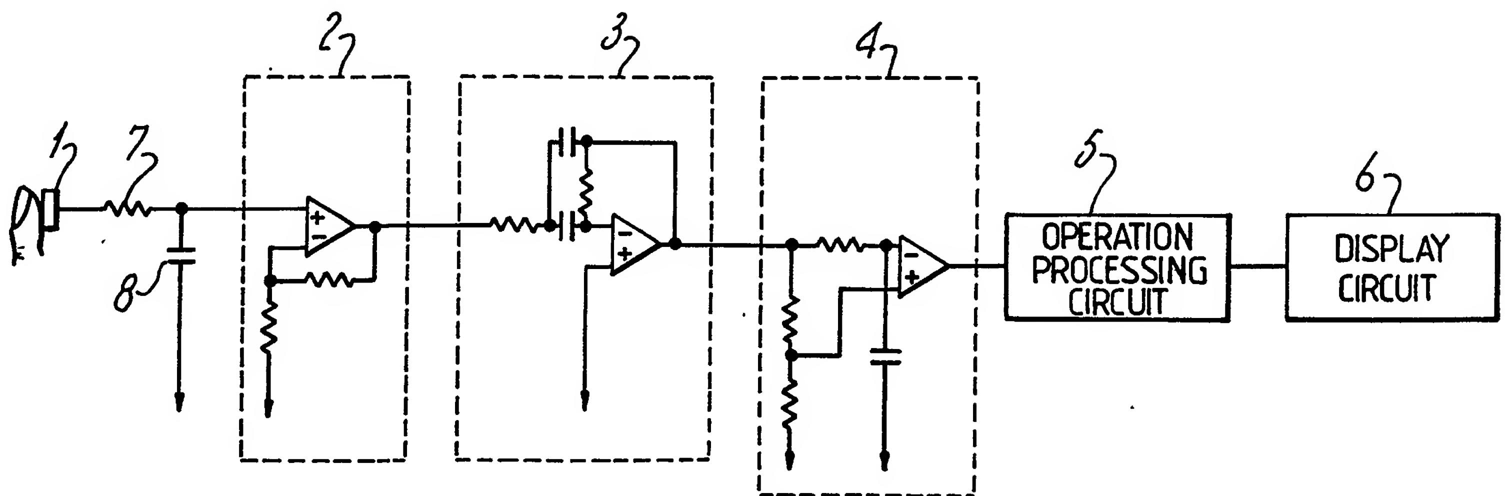


Fig.4.



SPECIFICATION

A heart-beat rate indicator

This invention relates to heart-beat rate indicators.

Conventionally, heart-beat rate is measured by electrocardiography where a small electrical signal produced by the heart prior to contraction is detected. It has been proposed to measure heart-beat rate by detecting the electrocardiac potential induced between two metal electrodes in contact with different parts of the human body. Theoretically, it should be possible to provide a small sized and long life heart-beat rate indicator because the electro-cardiac potential signal can be detected with low power dissipation, e.g. 100 μW.

Conventionall small, portable heart-beat rate indicators make use of electrocardiography. However, conventional circuitry and electrode construction is such that the input of the circuitry may be destroyed or damaged by electrostatic charge built up on, for example, clothes and transferred to the heart-beat rate indicator upon touching one of the electrodes. As a result the functioning of the conventional heart-beat rate indicator may deteriorate.

According to the present invention there is provided a heart-beat rate indicator comprising: a detection electrode receiving an electrocardiac potential signal; circuit means for receiving the electrocardiac potential signal for determining therefrom a heart-beat rate; and a low pass filter connected between the detection electrode and the circuit means.

In the preferred embodiment the low pass filter comprises a resistor and a capacitor.

The heart-beat rate indicator may include a display device for displaying the heart-beat rate.

Preferably the low pass filter is such as to attenuate signals in the megahertz band but pass the electrocardiac potential signal substantially without attenuation.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1 shows the waveform of a human heart-beat;

Figure 2 is a schematic diagram of a conventional heat-beat rate indicator;

Figure 3 shows graphically the discharge waveform of electrostatic charge; and

Figure 4 is a schematic diagram of one embodiment of a heat-beat rate indicator according to the present invention.

Throughout the drawings like parts have been designated by the same reference numerals.

Figure 1 shows the waveform of a human heart-beat. Generally, an electrocardiac potential signal induced between the arms of a person is composed of a P-wave, a Q-R-S wave and a T-wave, these appearing periodically. The amplitude of the Q-R-S wave is the largest of the three and ranges from about 0.2 mV to 1.0 mV. Normally, heart-rate indicators detect the Q-R-S wave.

On top of the electrocardiac potential signal is superimposed noise at commercial frequencies induced on the surface of the human body from outside. For heart-beat rate measurement it is necessary to eliminate large amplitude noise in order to detect the electrocardiac potential signal which is of small amplitude.

A conventional heart-beat rate indicator is illustrated in Figure 2. A detection electrode 1 is composed of, for example, stainless steel or silver chloride. When a person measures his heart-beat rate, a portion of the body surface, for example, the skin of one arm (left arm) acts as ground potential and the skin of the other arm (right arm) for example the tip of a finger, contacts the detection electrode 1. Thus the heart-beat rate indicator receives an electrocardiac potential signal. The ground potential may be applied to a casing of the heart-beat rate indicator when it is worn on the wrist.

The detection electrode 1 is connected to an amplifier circuit 2. The amplifier circuit 2 is an operational amplifier with a plurality of resistors so that it has a desired amplification factor. The electrocardiac potential signal and noise which is amplified by the amplifier circuit 2 is fed to a band-pass filter 3. The band-pass filter 3 consists of an operational amplifier, a plurality of resistors and a plurality of capacitors and has both a predetermined centre frequency and a predetermined Q-value. Noise at commercial frequencies is eliminated by the band-pass filter 3 so that only the electrocardiac potential signal appears at the output of the band-pass filter. The output from the band-pass filter 3 is fed to a voltage comparator 4. The voltage comparator 4 detects only the electrocardiac potential signal and produces a pulse signal at its output. This pulse signal from the voltage comparator 4 is fed to an operation processing circuit 5. The operation processing circuit 5 counts the period (T sec.) of the pulse signal fed thereto and determines the heart-beat rate from the number of pulses per minute. The relationship between the period (T sec.) of the pulse signal and the number P of heart-beats per minute, i.e. heart-beat rate, is given by:

$$P = 60/T$$

The output signal from the operation processing circuit 5 is fed to a display circuit 6 and drives a display device (not shown), for example, a liquid crystal display device to indicate heart-beat rate.

To conserve power the heart-beat rate indicator may be provided with a switching circuit for controlling the energy supply from a battery (not shown), the switching circuit being in an OFF state when the heart-beat rate is not being measured. However, an input transistor of the operational amplifier of the amplifier circuit 2 may be destroyed or damaged if the detection electrode 1 receives an electrostatic charge. Such electrostatic charge is readily produced, for example, by putting on or taking off clothing in

daily life. The electrostatic charge built up on the body surface is discharged when the detection electrode is touched irrespective of whether the heart-beat indicator is in use or not.

Figure 3 shows the discharge waveform of electrostatic charge. The peak voltage can reach several tens to several thousands of volts and the discharge time *t* may be several tens of nanoseconds to several thousands of nanoseconds.

Figure 4 shows a heart-beat rate indicator according to the present invention. Further description of the detection electrode 1, the amplifier circuit 2, the band-pass filter 3, the voltage comparator 4, the operation processing circuit 5 and the display circuit 6 is considered unnecessary. A low-pass filter is inserted between the detection electrode 1 and the amplifier circuit 2, the low-pass filter consisting of a resistor 7 and a capacitor 8. One side of the resistor 7 is connected to the detection electrode 1 and the other side is connected to the positive input of the amplifier circuit 2. One side of the capacitor 8 is connected to ground potential and the other side is connected to the positive input of the amplifer circuit 2.

The resistance value of the resistor 7 and the capacitance value of the capacitor 8 of the low-pass filter are determined by the desired cut-off frequency. The cut-off frequency is determined taking the following conditions into account:

discharge of the electrostatic charge (10 MHz — 100 MHz) is eliminated or attenuated

the electrocardiac potential signal (about 20 Hz) is passed without attentuation.

Determination of the cut-off frequency within the range of several hundreds to several thousands of hertz can satisfy these two conditions simultaneously.

The heart-beat rate indicator of Figure 4 is of relatively small size, has a relatively long life, simple and highly reliable. The low-pass filter protects the remainder of the heart-beat rate indicator against the application of electrostatic charge to its input. Thus the electrostatic charge can be eliminated or attenuated both when the heart-beat rate indicator is in use and when it is not and thus the heart-beat rate indicator is surely protected. Detection of the electrocardiac signal is not reduced since it is passed by the low-pass filter substantially without attenuation to the remainder of the heart-beat rate indicator.

CLAIMS

1. A heart-beat rate indicator comprising: a detection electrode receiving an electrocardiac potential signal; circuit means for receiving the electrocardiac potential signal for determining therefrom a heart-beat rate; and a low pass filter connected between the detection electrode and the circuit means.

2. A heart-beat rate indicator as claimed in claim 1 in which the low pass filter comprises a resistor and a capacitor.

3. A heart-beat rate indicator as claimed in claim 1 or 2 including a display device for displaying the heart-beat rate.

4. A heart-beat rate indicator as claimed in any preceding claim in which the low pass filter is such as to attenuate signals in the megahertz band but pass the electrocardiac potential signal substantially without attenuation.

5. A heart-beat rate indicator substantially as herein described with reference to and as shown in Figure 4 of the accompanying drawings.

6. A pulse detection circuit comprising a detection electrode receptive of electrocardiac signals of a person and a detection circuit for processing the electrocardiac signals, wherein the detection electrode is connected to the detection circuit through a low pass filter.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

PUB-NO: GB002113847A
DOCUMENT-IDENTIFIER: GB 2113847 A
TITLE: A heart-beat rate indicator
PUBN-DATE: August 10, 1983

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APPL-NO: GB08235124
APPL-DATE: December 9, 1982

PRIORITY-DATA: JP20429981A (December 17, 1981)

INT-CL (IPC): A61B005/02

EUR-CL (EPC): A61B005/0245

US-CL-CURRENT: 600/479 , 600/500 , 600/508 , 600/509

ABSTRACT:

A heart-beat rate indicator comprises a detection electrode (1) receiving an electrocardiac potential signal, circuitry (2, 3, 4, 5) receiving the electrocardiac potential signal and determining therefrom a heart-beat rate,

and a low-pass filter (7, 8) connected between the detection electrode and the circuitry to attenuate signals in the megahertz band and pass the electrocardiac potential signals substantially without attenutation, thus protecting the heart-beat rate indicator from the application of electrostatic charge. Circuits 2, 3 and 4 comprise a conventional amplifier, band pass filter and comparator, respectively.